DON'T CALL US, WE'LL CALL YOU!

Suggested Grades

9 and 10

SD Mathematics Strand & Standard *(Primary for Task)*

Algebra

9-12.A.2.1. Students are able to use algebraic properties to transform multi-step, single-variable, and first-degree equations.

9-12.A.2.2. Students are able to use algebraic properties to transform multi-step, single-variable, and first-degree inequalities and represent solutions using a number line.

Task Summary

Students develop mathematical models to represent cell phone rate programs and justify their selection of their preferred plan.

Time and Context of Task

3-4 days, including presentations
Groups of 2-3 students

Materials Needed

Paper, pencil, graphing calculator, chart or graph paper

Author and Lead Teacher for This Task

Cindy Kroon Montrose High School

Credits for This Task

Rate Sources: SD Cellular One Representative 6/24/04
Qwest Sales Representative 6/24/04

See also Principles and Standards for School Mathematics © 2000 by NCTM, pages 223-225, 297-298

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Your cell phone contract is up for renewal. You are considering Cellular One and Qwest as you choose a new wireless service provider. Both companies feature unlimited night/weekend minutes.

Cellular One offers the following rate plans for local service:

Plan	Monthly Service Fee	Daytime Minutes Included	Additional Minutes Over Plan
A	$30.00	400	$.39 per minute
B	$40.00	1000	$.39 per minute
C	$75.00	1500	$.39 per minute

(Source: Cellular One 6/24/04)

Qwest offers the following rate plans for local service:

Plan	Monthly Service Fee	Daytime Minutes Included	Additional Minutes Over Plan
A	$29.99	200	$.30 per minute
B	$59.99	1000	$.30 per minute
C	$199.99	Unlimited	

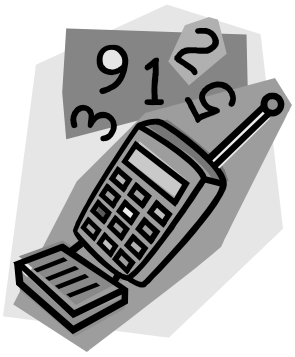
(Source: Qwest 6/24/04)

*(Assume both Cellular one and Qwest bill for the exact amount of time used, rather than rounding up to the next full minute.)**

From the given information, develop a mathematical model for each plan. Under which circumstances would a given plan be the best choice? Based on the best economics, which plan would ***you*** choose? Prepare a presentation to describe your results. Your presentation should include the following:

- Equations which describes the monthly cost as a function of minutes used *for each of the six plans*
- An explanation of the meaning of *slope* and *y-intercept* in the context of this problem.
- A graph comparing the three Cellular One plans
- A graph comparing the three Qwest plans
- Compare the six plans. Under which conditions would each be the best choice?
- Consider your own telephone habits. Which plan would ***you*** choose? Justify your answer.

As a class, discuss the presentations.



Content Standards

Primary Standards

Strand Name: Algebra

SD Goal 1: Students will use the language of algebra to explore, describe, represent, and analyze number expressions and relations that represent variable quantities.

Indicator 3: Interpret and develop mathematical models.

Standard: 9-12.A.3.1. Students are able to create linear models to represent problem situations.

Indicator 4: Describe and use properties and behaviors of relations, functions, and inverses.

Standard: 9-12.A.4.1. Students are able to use graphs, tables, and equations to represent linear functions.

Supplemental Standard

Strand Name: Algebra

SD Goal 1: Students will use the language of algebra to explore, describe, represent, and analyze number expressions and relations that represent variable quantities.

Indicator 3: Interpret and develop mathematical models.

Standard: 9-12.A.3.2A. Create formulas to model relationships that are algebraic, geometric, trigonometric, and exponential.

NCTM Process Standards

Communication:

- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
- Use the language of mathematics to express mathematical ideas precisely

Connections

- Recognize and apply mathematics in contexts outside of mathematics

Representation

- Create and use representations to organize, record, and communicate mathematical ideas.
- Use representations to model and interpret physical, social, and mathematical phenomena.

Problem-Solving Strategies

- Developing formulas and writing equations
- Drawing pictures, graphs, and tables

Assessment Tools

Task Rubric

	Advanced	Proficient	Basic	Below Basic
9-12.A.3.1. Students are able to create linear models to represent problem situations	The solution shows a deep understanding of the problem including the ability to identify the appropriate mathematical concepts and the information necessary for its solution.	The solution shows that the student has a broad understanding of the problem and the major concepts necessary for its solution.	The solution is not complete indicating that parts of the problem were not understood.	There is no solution OR the solution addresses none of the mathematical components in the task.
9-12.A.4.1. Students are able to use graphs, tables, and equations to represent linear functions.	Accurate graphs are shown and labeled correctly. The student can completely explain the graphs in context.	Accurate graphs are shown and labeled. The student can explain the meaning of the graphs.	Graphs are shown, but are not completely accurate, OR are not adequately explained by the student.	Incomplete graphs are shown, OR the graphs do not address the mathematical components of the task. The student cannot explain the meaning of the graphs.
9-12.A.4.1. Students are able to use graphs, tables, and equations to represent linear functions.	Accurate equations are written. The student can completely explain the meaning of each term.	Accurate equations are written. The student can explain in his/her own words what terms represent/	Equations are written, and are generally accurate. The student cannot explain what each term represents.	Equations are not accurate OR missing OR the student cannot explain what the equations represent.
NCTM Process Standard: Communicate mathematically	Clearly and consistently uses language that is mathematically correct.	Uses clear language that frequently includes appropriate mathematical terminology.	Uses language that sometimes is mathematically correct.	Uses vague language that does not use mathematical terminology.
NCTM Process Standard: Mathematical Representation	Mathematical representation (figures, diagrams, graphs, tables, etc.) is actively used as a method of communicating ideas related to the solution of the problem.	There is appropriate use of effective mathematical representation (figures, diagrams, graphs, tables, etc.)	There is some use of appropriate mathematical representation. (figures, diagrams, graphs, tables, etc.)	There is no use or inappropriate use of mathematical representation. (figures, diagrams, graphs, tables, etc.)

Created using http://www.exemplars.com/math_rubric.html

Core High School Algebra
Performance Descriptors

Advanced	**High school students performing at the advanced level:** • transform algebraic expressions; • solve quadratic equations; • solve a system of linear equations.
Proficient	**High school students performing at the proficient level:** • transform polynomial expressions using real number properties; • solve single variable linear equations with integral coefficients; • graph linear equations; • interpret tables, graphs, and charts to solve problems; • create a linear model from a problem context.
Basic	**High school students performing at the basic level:** • transform linear expressions with integral coefficients using real number properties; • solve linear equations of the form $ax + b = c$, where a, b, and c are integers; • recognize the graph of a linear equation; • graph a line from a table of values.

Core High School Algebra
ELL Performance Descriptors

Proficient	**High school ELL students performing at the proficient level:** • solve, transform, and graph linear equations; • apply algebraic representations to solve problems; • read, write, and speak the language of algebra and apply it to algebraic problem-solving situations.
Intermediate	**High school ELL students performing at the intermediate level:** • solve one-variable linear equations; • graph linear equations in slope-intercept form; • complete tables to graph linear equations; • create numerical expressions from oral or written contexts; • evaluate an algebraic expression given the value of the variable(s); • explain in algebraic terms the steps and/or strategies used in problem solving; • give oral, pictorial, symbolic (diagrams) or written responses to questions on topics presented in class.
Basic	**High school ELL students performing at the basic level:** • graph points on a coordinate system; • solve problems with integral and rational solutions; • evaluate numerical expressions; • demonstrate problem-solving strategies; • break tasks into smaller parts and make connections to prior knowledge; • recognize, compare, and use appropriate algebraic terms; • respond to yes or no questions and to problems presented pictorially or numerically in class.
Emergent	**High school ELL students performing at the emergent level:** • identify and use mathematical symbols; • copy and write numerals and algebraic symbols; • imitate pronunciation of numerals and mathematical terms; • use non-verbal communication to express mathematical ideas.
Pre-emergent	**High school ELL students performing at the pre-emergent level:** • observe and model appropriate cultural and learning behaviors from peers and adults; • listen to and observe comprehensible instruction and communicate understanding non-verbally.

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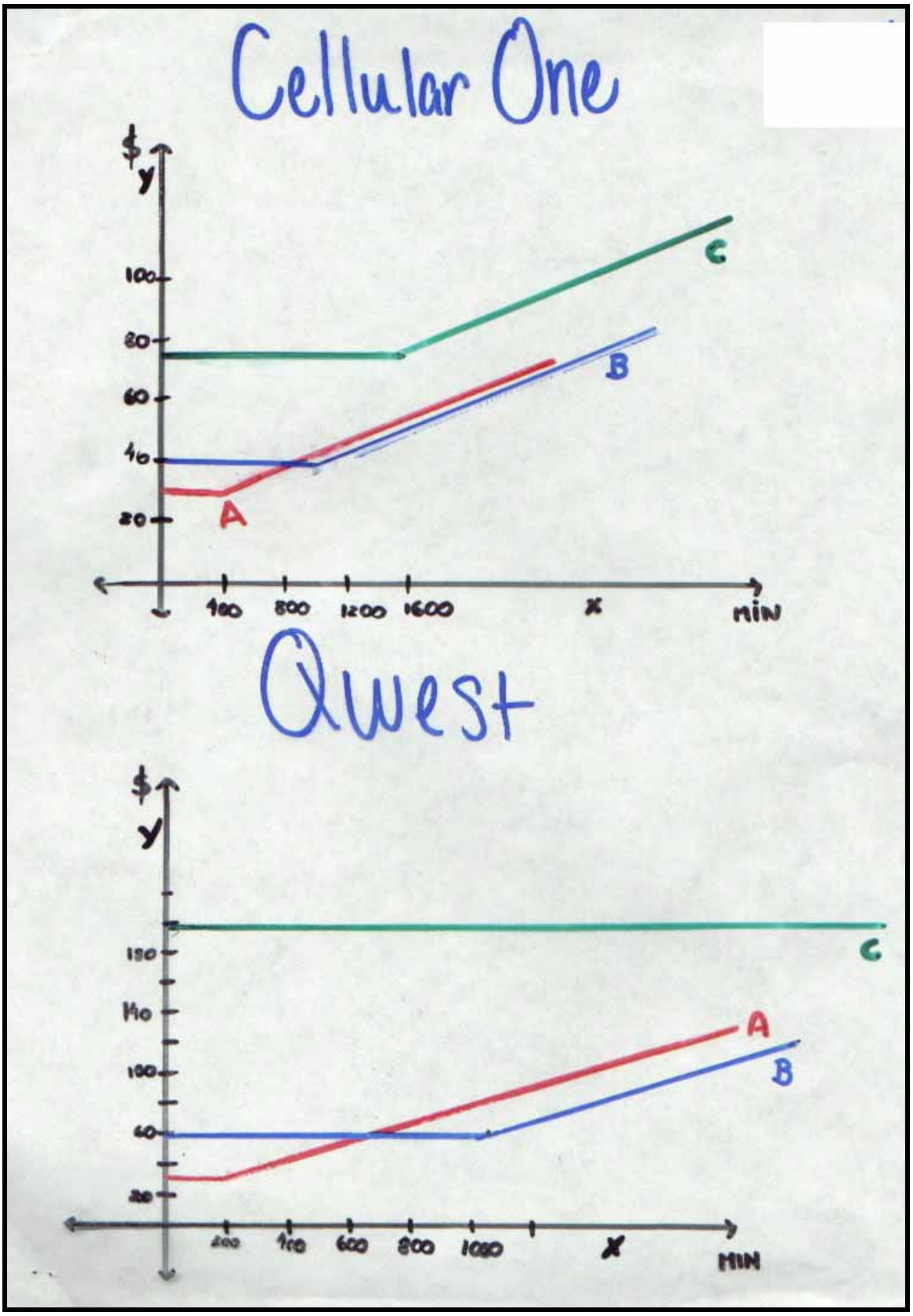
Student Work Samples

As you examine the samples, consider the following questions:

- In light of the standard/s addressed and the assessment tools provided, what evidence does the work provide that students are achieving proficiency in the knowledge and skills addressed by the standard/s for the task?
- Is the task/activity well designed to help students acquire knowledge and demonstrate proficiency? Is the task/activity clearly aligned with the standards? In what ways would you adapt the task/activity to better meet the needs of your students?

Student Work Sample #1



Sample #1 – page 2

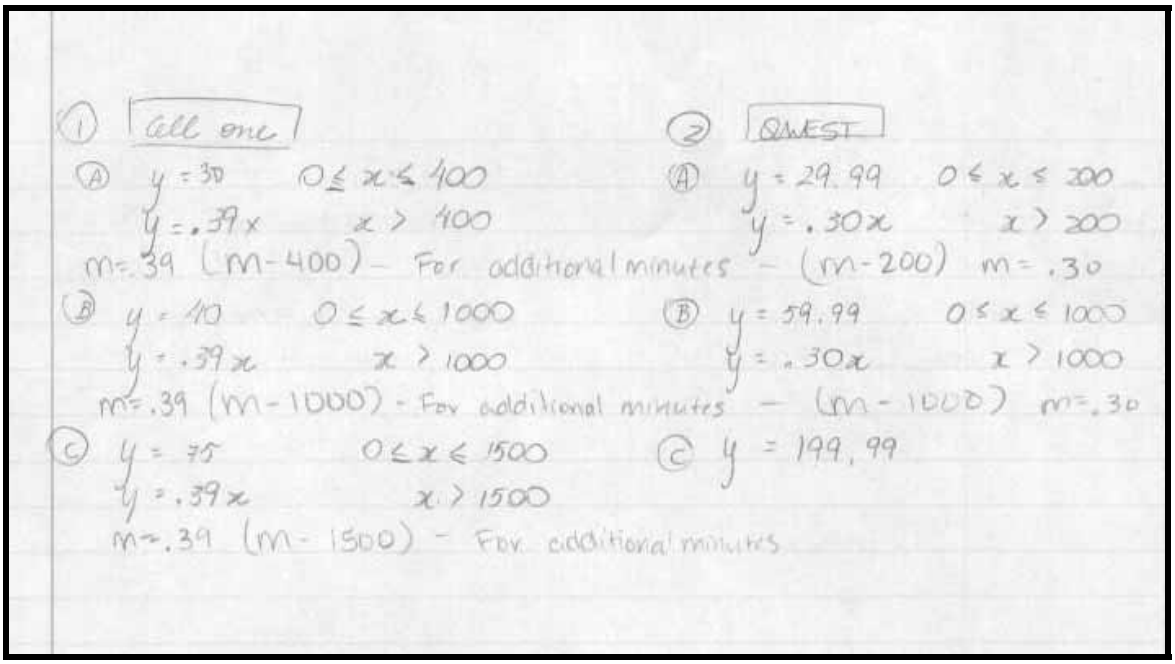
The slope and y-intercept in context to this problem is the y-intercept is the cost in each of the graphs and the slope is the cost of the additional minutes if over the original amount.

Cellular ones had 3 plans with all the same slopes and different y-intercepts. Plan A has a y-intercept of 30 and a slope of 2/5. If you don't talk a lot on the phone you would want this plan because it's cheapest plan the maximum amount of minutes for you. Plan B has a y-intercept of 40 and has a slope of 2/5. If you talk a fair amount then this is the plan for you because you get 1000 daytime minutes for the second cheapest price of 40 dollars. Plan C has a y-intercept of 75 and a slope of 2/5. If you spend most of your time on the phone then you would want this plan because you get the most amount of minutes for cellular one for 75 dollars.

Qwest had 3 plans with the same slopes but different y-intercepts. Plan A had a y-intercept of 29.99 and a slope of 1/3. If you don't spend hardly any time on the phone this is the plan for you because you the 200 minutes for the cheapest price. Plan B had a y-intercept of 59.99 and a slope of 1/3. If you're a regular talker on the phone then you would want this plan because you get 1000 minutes for 59.99 with a cheaper rate of 30 cents of you go over. Plan C has a y-intercept of 199.99 and no slope because its unlimited. If you're a person who spends every waking minute on the phone then this would be the plan you would want because you can talk as much as you want for 199.99.

The Plan that is best for Carolina and I would be from Cellular One and the plan would be plan B. We chose this plan because we spend a fair amount of time on the phone and its cheaper then Qwest's 1000 minute plan.

Sample #1 page 3

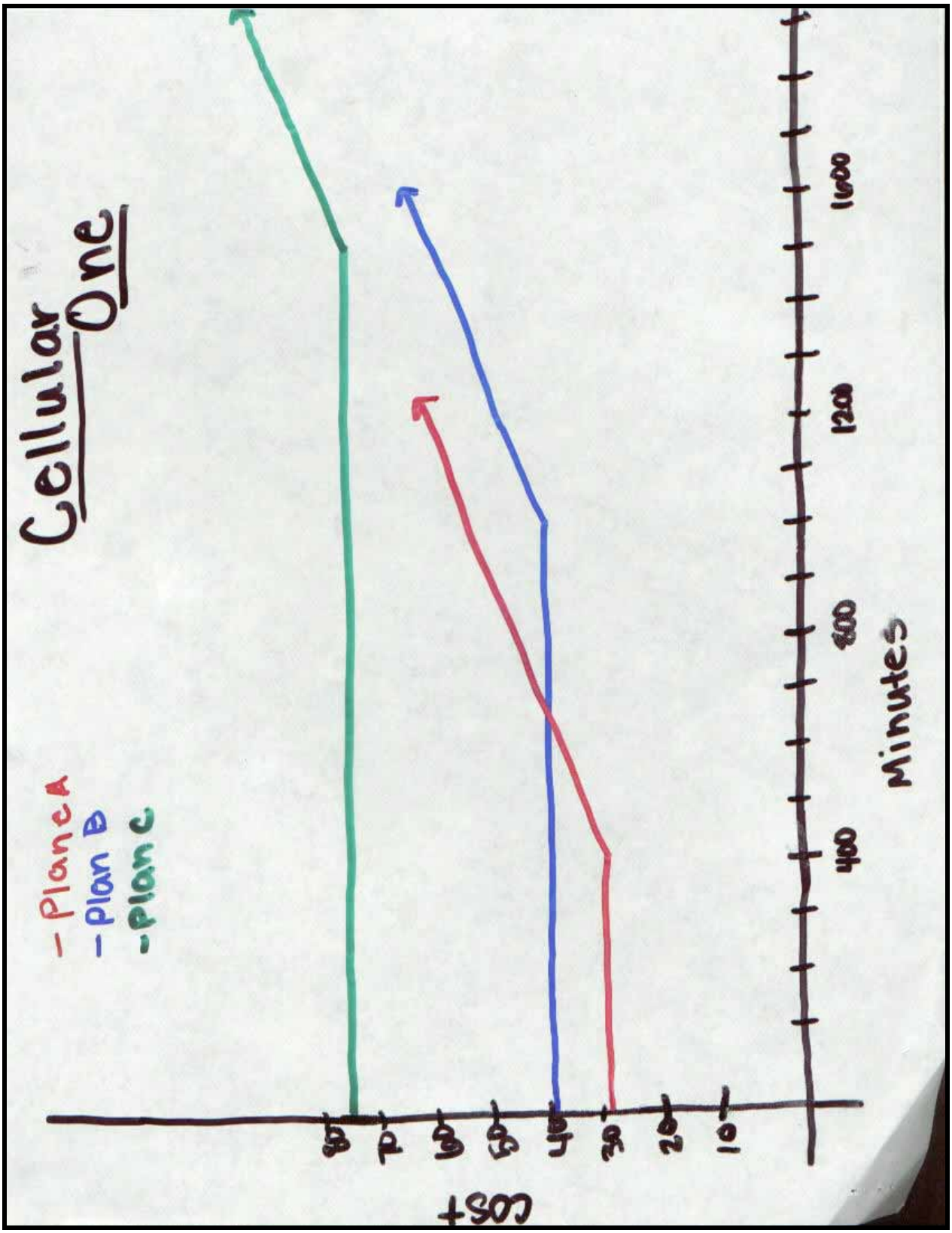


Looking at Student Work – Instructor notes and rating for work sample #1:

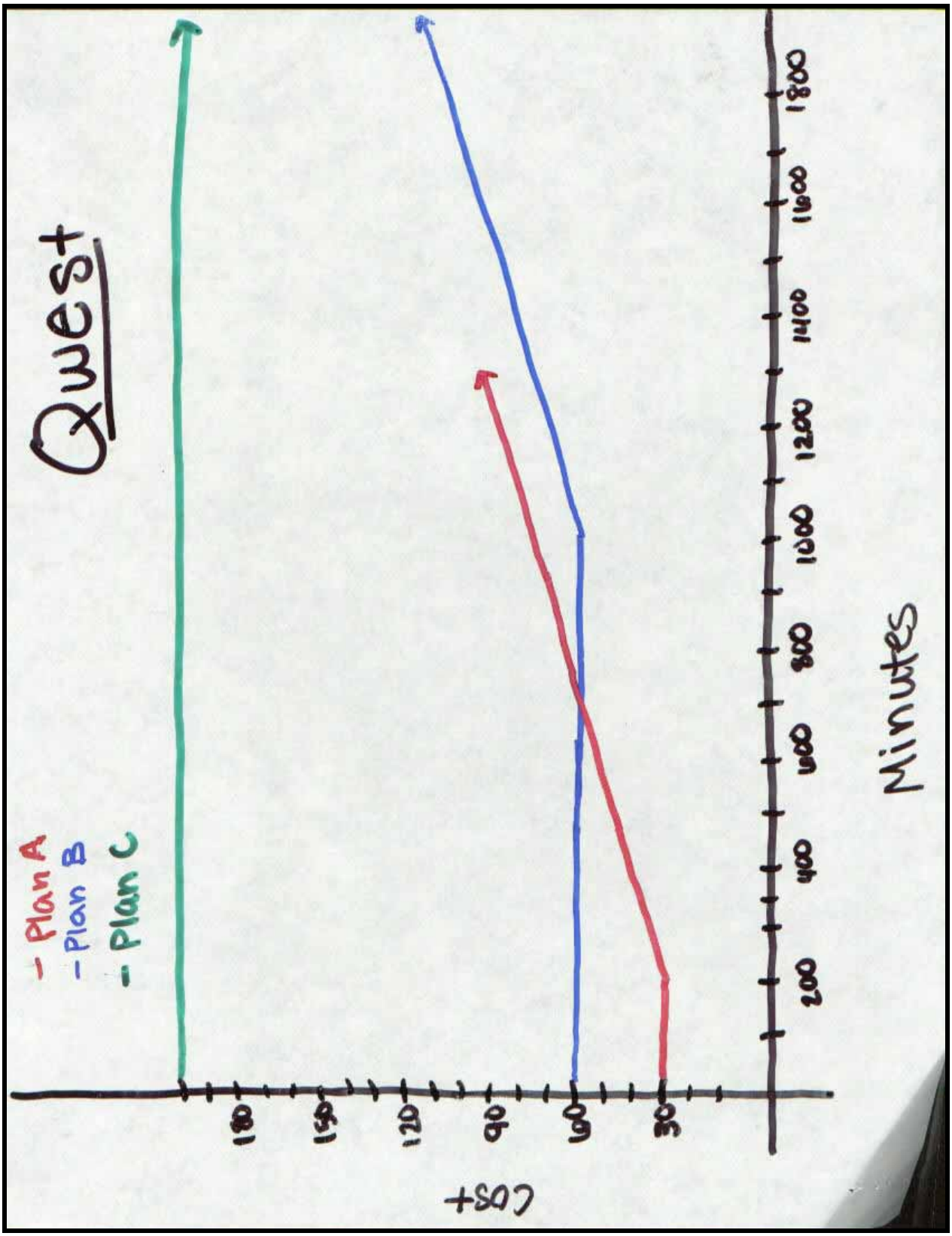
This project was rated proficient. The solution shows that the students had a broad understanding of the concepts. Accurate graphs are drawn and equations are accurately described. There is appropriate use of effective mathematical representation. In the student discussion, there was a small misconception of the slope of a horizontal line. Students were able to explain that they meant "no vertical change" when they said "no slope." Other than that small error, the students did a good job using mathematical language correctly.

The students were able to answer questions about their problem solving process and the meaning of their solutions during their oral presentation.

Student Work Sample #2



Sample #2 - page 2



Sample 3 – page 3

For Cellular One Plan A people that would have the interest in purchasing this plan would be those who only use their cell phone for emergencies and a short call here and there. Plan B would be used mainly by teenagers who use it just to get a whole of their friends and to call if they are going to be late getting home. Plan C would be used by someone who may make most of his or her long distance calls on his or her cell phone.

For Qwest Plan A is similar to Cellular One Plan A only this would more than likely be used just for emergencies only. Plan B would be used by teenagers will to pay $20 more than Cellular One Plan A to call their friends and family. People who use only their cell phone for everything, such as work and their home phone, would use plan C.

Blake and I chose Cellular One plan B. We chose this plan because being teenagers we need lots of minutes but not too many. The price of $40 for 1000 minutes is very affordable for teenagers like Blake and I.

In this project there were many different equations used they were:

Cellular One;

Plan A- $0 \leq m \leq 400$ $y=.39(m-400)$ $m>400$ etc.
Plan B- $0 \leq m \leq 1000$ $y=.39(m-1000)$
Plan C- $0 \leq m \leq 1500$ $y=.39(m-1500)$

Qwest;

Plan A- $0 \leq m \leq 200$ $y=.30(m-200)$
Plan B- $0 \leq m \leq 1000$ $y=.30(m-1000)$
Plan C- $m=199.99$ $y=199.99$

These equations were found by finding the slopes by putting price per minute over 100 and reducing. Y-intercept was determined by the number of minutes you use minus the minutes between 400 and 1000 and 1500... and so on.

?? not sure what you mean by that

Looking at Student Work – Instructor notes and rating for work sample #2:

This project was scored at the basic level. Although students had a general understanding of the problem, some parts of the solution were incorrect or incomplete. Specifically, some parts of the model are not described by their equations. There is appropriate use of mathematical representation, but the written discussion is not always mathematically correct. The last paragraph is unclear. Students were able to clarify orally when questioned during their presentation.

INSTRUCTIONAL NOTES

Author comments

Since students take more seriously what is evaluated, I anticipate that the project evaluation (point grade) will count approximately ½ that of a test grade

Task Extensions

- Have students compare their own cell phone plan or that of their parents to the model presented.
- Have students investigate some of the issues that were omitted to simplify the task. i.e. Time is measured precisely rather than to the next minute. What implications does this have?*
- Present fewer options to make the task less challenging. Perhaps limit the choices only to a single provider, or to one plan from each provider.
- Limit the choices to two plans, each with the same number of minutes.
- Have students compare a linear function and a step function in the context of the problem.*
- Present more options to make the task more challenging. Students may want to also consider the cost of long distance/nationwide service in addition to the local/basic rate.

Appropriate Technology

- Graphing calculator
- TI-Connect Software
- Excel or other spreadsheet software
- PowerPoint or other presentation software

Interdisciplinary Connections

Social Studies:

- How has cell phone availability changed the way we interact at work and elsewhere?
- Cell phone use while driving and its impact on safety

Teacher Resources

http://rubistar.4teachers.org/index.php
http://www.exemplars.com/math_rubric.html
Principles and Standards for School Mathematics © 2000 by NCTM, pages 223-225, 297-298

Resources

SD Mathematics Content Standards
http://www.doe.sd.gov/contentstandards/math/index.asp

SD Assessment and Testing
http://www.doe.sd.gov/octa/assessment/index.asp

The National Assessment of Educational Progress (NAEP)
http://www.doe.sd.gov/octa/assessment/naep/index.asp

National Council of Teachers of Mathematics
http://nctm.org/

Looking at Student Work
http://www.lasw.org/index.html